THURSDAY, JANUARY 15, 1874

THE POLLUTION OF RIVERS

THE Rivers-pollution Commissioners (Prof. Frankland and Mr. J. C. Morton), having, during the last five years, made and published more than 2,000 analyses of river and other waters throughout England, Scotland, and Wales, before and after pollution, and no less than 1,200 examinations of impure drainage waters, and having visited and reported concerning the effluent waters from 245 Chemical-dye and Print-works, Paper-, Cotton-, and Woollen-mills, and mines and works of various kinds spread over the country, have recently published their fifth report on river pollution from mining operations, reserving to themselves in their forthcoming and last report the consideration of the potable waters of Great Britain.

The importance of this systematic and thoroughly scientific examination of the composition of the running water on the surface of our country can hardly be over-estimated, and the value to the nation of the mere analyses of the waters is such as amply to repay the cost of the Commission. In addition, however, to the special value to each district, to corporate bodies, or even to individual manufacturers and riparian proprietors which these analyses of river and drainage waters possess, they are of the highest importance as forming the body of evidence upon which alone action can be taken with regard to legislation on the subject of the prevention or abatement of river pollution throughout the country. That some measure to ensure a greater degree of purity in our rivers, especially those passing through the manufacturing districts, must, before long, be carried out by the Legislature, is admitted not only by those who opposed Mr. Stansfield's proposals of last year, but even by the manufacturers who are now helping to foul the streams. The question which has to be settled is not whether anything is to be done to remedy the certainly disgraceful state of some of our streams, but rather to what extent can the purification be pushed without detriment to the industry of the district; and when this has been decided comes the next question, how this partial purification is to be effected. That it can only be a partial purification is clear from the conclusions of the Commissioners themselves, who do not propose any plan by which the water of our rivers, in populous districts at present little better than sewers, shall be so purified as to be fit for drinking purposes.

Without attempting to give even a part of the data upon which the Commissioners base their conclusions, and declining altogether, as inopportune, to criticise their scheme, it appears to be desirable that conclusions arrived at after so much labour and consideration should be made widely known.

The proposal, then, which the Commissioners make as in their opinion the best and most feasible means of legislating on the prevention of river pollution is the establishment of certain standards, the infringement of which shall render the water liable to be deemed polluting and inadmissible into any stream, provided always that no effluent water shall be deemed polluting if it be not more contaminated with any of the polluting ingredients than the stream or river into which it is discharged.

The standards are as follows :—

(*a*) Any liquid which has not been subjected to perfect rest in subsidence-ponds of sufficient size for a period of at least six hours ; *or* which having been so subjected to subsidence, contains, *in suspension*, more than one part by weight of dry organic matter in 100,000 parts by weight of the liquid, *or* which, not having been so subjected to subsidence, contains, *in suspension*, more than three parts of dry mineral matter, or one part by weight of dry organic matter in 100,000 parts by weight of the liquid.

(*b*) Any liquid containing, *in solution*, more than two parts by weight of organic carbon, or 0·3 part by weight of organic nitrogen in 100,000 parts by weight.

(*c*) Any liquid which shall exhibit by daylight a distinct colour when a stratum of it one inch deep is placed in a white porcelain or earthenware vessel.

(*d*) Any liquid which contains, in solution, in 100,000 parts by weight, more than two parts of any metal except calcium, magnesium, potassium, and sodium.

(*e*) Any liquid which, in 100,000 parts by weight, contains, whether in solution or suspension, in chemical combination or otherwise, more than 0·05 part by weight of metallic arsenic.

(*f*) Any liquid which, after acidification with sulphuric acid, contains, in 100,000 parts by weight, more than one part by weight of free chlorine.

(*g*) Any liquid which contains, in 100,000 parts by weight, more than one part by weight of sulphur, in the condition either of sulphuretted hydrogen or of a soluble sulphuret.

(*h*) Any liquid possessing an acidity greater than that which is produced by adding two parts weight of real muriatic acid to 1,000 parts by weight of distilled water.

(*i*) Any liquid possessing an alkalinity greater than that produced by adding one part by weight of dry caustic soda to 1,000 parts of distilled water.

(*k*) Any liquid exhibiting a film of petroleum or hydrocarbon oil upon its surface, or containing, in suspension, in 100,000 parts, more than 0·05 part of such oil.

The Commissioners further add that any law having for its object the prevention of river pollution, should

1. Absolutely forbid, under adequate penalties, the casting of solid matters into river channels.

2. Enact the foregoing standards of purity below which any liquid discharges into water-courses should, with the exceptions already mentioned (certain few short mining rivers), be forbidden.

3. Give power to all manufacturers in towns, except those of gas, paraffin oil, pyroligneous acid, animal charcoal, tin-plate, and galvanised iron, to discharge their drainage water into the town-sewers under suitable regulations.

4. Confer additional powers on corporations, local boards, manufacturers and mine-owners, to take land compulsorily under "Provisional orders" for the purpose of storing their waste refuse, or of cleansing sewage or other foul liquids either by irrigation, filtration, or otherwise.

They are of opinion that Government Inspectors

(similar to the Inspectors under the Alkali Act) should be appointed, to whom should be committed the duty of detecting and proving offences against the law, and of procuring the conviction of offenders. They consider that the formation of River Conservancy Boards for authorising and carrying out river improvements will in course of time become imperative, but they are convinced that the thing of immediate importance in connection with river improvement throughout the country, is simply the prohibition, under adequate penalties, of the gross pollution which at present renders so much of the running water of this country useless to manufacturers, agriculturists, and the like.

The time has not yet arrived for the full discussion of these proposals. We shall doubtless hear much on this subject in the approaching or in the next session in parliament. It is, however, certain, from the opposition made to the bill of last year, that manufacturers do not as a rule agree with the Commissioners as to the feasibility of enforcing the proposed standards of purity, as regards the effluent water from works of various kinds. Nor is public opinion respecting the other and far more important source of pollution, the sewage of towns, in a sufficiently advanced or satisfactory condition to render legislation easy. It is not, for instance, clear how one and the same system, say of irrigation, can be applied to all districts possessing different soils, rainfalls and situations. Indeed, the more we consider the whole question of the prevention of the pollution of rivers, the more difficult does any general method of treatment appear to be. Each locality has its own peculiarities, and a system of prevention which is suited to one district may be inapplicable or inexpedient in another. But even supposing that when the subject comes before Parliament that difficulties are found to be of such a character as to render it impossible to legislate upon the exact basis laid down by the Commissioners, still the value of their conclusions, and of the mass of experimental evidence which they have collected, is extreme: and they have most fully earned the gratitude of all those interested in the satisfactory solution of one of the most important, though most difficult, questions of our social economy.

THE CONSERVATION OF ENERGY

An Elementary Treatise on Energy and its Laws. By Balfour Stewart, M.A., LL.D., F.R.S., Professor of Natural Philosophy at the Owens College, Manchester. (Henry S. King & Co., 1873.)

IT is the proper function of Science to discover, among the ever-changing phenomena of the world, the permanent relations which are the conditions of reasonable thought. When we understand these relations well enough to express them in words we call them "Laws of Nature." When they rise to a higher stage of development and have become invariable habits of thought, we call them "Things."

Thus ice, under certain conditions, ceases to be ice. We observe that when the ice melts water appears in its place, and we find that there is always so much water in place of so much ice. We therefore obtain, in the first instance, a *law* of equivalence between a certain quantity of ice and a certain quantity of water, and finally, we arrive at the conclusion that water and ice are the same *thing* in different forms.

We are thus led to inquire what it is which remains permanent in the midst of all apparent changes, and the result of this inquiry has been the enunciation of a consistent definition of the quantity of matter in a body, and the establishment of the doctrine that the quantity of matter in a body is invariable, whatever transformations it may undergo.

This doctrine of the "Conservation of Matter" lies at the foundation of all reasoning, whether in physics or in chemistry. When the progress of Science rendered it possible to form exact ideas about the motion of bodies, men were again impelled to seek for something permanent, even in motion itself. They endeavoured to form some definition of the "Quantity of Motion" which should enable them to treat this quantity as a *thing* having a continuous existence. The long war between the followers of Newton and those of Leibniz as to whether, in estimating the quantity of motion, the mass must be multiplied into the velocity or into the square of the velocity, was not a mere debate about words and names, for it involved the question whether momentum or *vis viva* were the more fully possessed of that character of permanence which would justify its claim to the title of "The Quantity of Motion."

The doctrine of the Conservation of Energy is the most complete expression hitherto given to the belief that all the changes of phenomena are but different distributions of the same stock of energy, the total quantity of which remains invariable. The characteristic feature of scientific progress during the last thirty years has been the application of principles derived from this doctrine to the various branches of Science. The recent progress of the theory of heat is an instance of the direct and conscious application of the doctrine of the conservation of energy. In his electrical discoveries Faraday also was guided by the same doctrine, though less consciously, as he had no opportunity of becoming acquainted with it in the accurate form in which it may now be stated.

In the volume before us Dr. Balfour Stewart has explained, in a very clear and very elementary manner, what is meant by energy in its two forms, the energy of a moving system, and the energy due to the configuration of the system.

This exposition is so carefully drawn up that we think it ought to be intelligible even to students who approach the subject without any previous training in the technical dynamics of the ordinary text-books. This we consider a matter of great moment for the future progress of Science. It is no doubt easier, in dealing with the present generation of students, to gain their assent to doctrines about energy by deducing them from other principles which have been already taught them as the elementary principles of dynamics. But it is by no means always true in science that those principles which have been longest recognised are really the most elementary. The discovery of principles more fundamental and elementary than those which are already received, is not only of great importance in the philosophy of Science, but it tends to render Science less technical, and therefore more easily diffusible through the mass of society.